The Laryngeal Mask Airway (its potential for the military)

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SUMMARY: The introduction of the laryngeal mask airway (LMA) in the early 1980s has revolutionised airway management. Clinicians have shown the ease of LMA insertion compared to endotracheal intubation by unskilled personnel. Despite the lack of protection against aspiration of gastric contents, the LMA's ability to maintain the airway and oxygenation warrants its incorporation into military life support protocols and into an integrated respiratory support concept for conventional and NBC operations.

Introduction

Until recently airway management during anaesthesia and resuscitation had been mainly a choice between a face mask and endotracheal intubation. The face mask although easy to use does not secure the airway, whilst endotracheal intubation provides a secure airway but is more technically difficult to perform.

Fig 1. The Brain Laryngeal Mask Airway.

The Brain Laryngeal Mask Airway (LMA), (see Fig 1), has revolutionised airway management as an easy to use, versatile and unstimulating airway device. It provides a halfway house between the two conventional methods of securing the airway and is of special use in the failed intubation drill and as an aid to intubation. The LMA is now gaining acceptance as a method for other health care workers to use for maintaining the airway in resuscitation. It should therefore be considered for use in the battlefield environment by its incorporation into the British Army Trauma Life Support (BATLS) programme and into an integrated respiratory support concept for conventional and NBC operations.

History and Development

The LMA was invented by Dr A Brain at the London Hospital, Whitechapel in 1981 and was first described in 1983 (1). It was initially made from a size 10 Portex endotracheal tube with the distal end removed (including the cuff), and replaced by a black rubber cuff from Goldman Dental Mask. This design was chosen so it would sit in the hypopharynx, (see Fig 2), and when the cuff was inflated, via a pilot balloon, form a reasonable seal over the laryngeal inlet.

Fig 2. Position of LMA once inserted.

Initially there was only one size, with four sizes becoming commercial available in 1988 (2).

The choice of sizes then was:

Size 1 - neonates/infants up to 6.5kg

Size 2 - children up to 25kg

Size 3 - children over 25kg/small adults

Size 4 - normal/large adults

Later a size 2.5 was added as a large gap was found to exist between sizes 2 and 3. All sizes are additionally available with a flexible armoured stem. Indications for use are listed in Table 1.

Table 1

Indications for using an LMA:

- i: Anaesthesia
- ii: Aid to intubation
- iii: Failed intubation
- iv: Resuscitation
- v: Laryngoscopy/Bronchoscopy

i. Anaesthesia

The LMA provides an airway with the advantages of:

- a. ease of insertion,
- b. no direct contact with the trachea or vocal cords,
- c. reasonable protection of the airway against soiling from above (3),
- d. less cardiovascular stimulation than seen with endotracheal intubation (4),
- e. it leaves the anaesthetist's hands free once inserted.

The LMA is removed only when the patient is awake and all protective reflexes have returned. This is possible while still allowing a smooth recovery from anaesthesia because the LMA is well tolerated once in situ. This lack of stimulation also means a lower incidence of gagging or coughing which is very important in certain surgical procedures e.g. intra-ocular or middle ear operations.

The LMA can be used with the patient breathing spontaneously or with intermittent positive pressure ventilation (IPPV). IPPV is possible as long as the peak inspiratory pressure does not exceed 20cm of water, otherwise gastric distension can occur increasing the risk of regurgitation and aspiration of gastric contents (5).

Although the laryngeal anatomy in children varies from that seen in the adult, the LMA provides a satisfactory airway of 97% in cases (6).

The LMA is not without its problems. Aspiration of gastric contents carries a significant morbidity and potential mortality (7). The LMA has been shown to decrease lower oesophageal sphincter tone (8) and in one small study of a low risk population there was an incidence of regurgitation of 25% (9). This study however showed no evidence of aspiration in those patients that had regurgitated. Another study of 2359 patients showed an incidence of regurgitation of only 0.08% (10). The LMA is not designed for elective use in patients with a high risk of aspiration and is thus contraindicated in these patients.

This however may change to some degree in the future with a new prototype of the LMA (11). It has a second cuff increasing the barrier between the oesophagus and the respiratory tract and also an oesophageal channel for venting regurgitated stomach contents.

Other reported problems are: trauma to the airway, laryngospasm, kinking of the tube and failure or delay to recognise incorrect positioning. These can all be avoided, provided the appropriate checks of the LMA are made and the correct methods of insertion and monitoring are adhered to (12). The incidence of sore throat has been shown to be similar to that found when using a face mask (5). Contraindications to the LMA are listed in Table 2.

Table 2

Contraindications to the use of the LMA:

- Full stomach
- Hiatus Hernia
- Morbid obesity
- Delayed gastric emptying e.g. pregnancy >14 weeks, acute abdomen, opioids, autonomic neuropathy
- Low lung compliance e.g. Pulmonary fibrosis

ii. Aid to endotracheal intubation

Several methods involving the use of an LMA have been used to facilitate intubation including: passing a size 6 endotracheal tube (13), a bougie (14) or a fibreoptic bronchoscope (15), through the LMA into the trachea. This has often proved of value when the laryngeal inlet has been difficult to visualise on direct laryngoscopy.

iii. Use in the failed intubation drill

When endotracheal intubation has been attempted and proved to be impossible, and/or ventilation via a face mask and pharyngeal airway is inadequate, the LMA can provide a temporising solution, thus avoiding the need for an emergency surgical airway (16).

There is controversy over its use in failed intubation in patients with a higher than normal risk of aspirating gastric contents especially in obstetrics (17,18). In one study, the LMA could be positioned correctly in only 13 out of 22 patients while cricoid pressure was maintained (19). Cricoid pressure involves an assistant pressing on the cricoid cartilage with 3 fingers of one hand, so as to compress the upper oesophagus between the cartilage anteriorly and the cervical vertebrae posteriorly, the intention being to prevent regurgitation (20). This may effect the positioning of the tip of the LMA which would normally rest in the upper oesophagus. One solution is to follow the algorithm in Figure 3.

Fig 3. The failed intubation drill in a patient with a full stomach (21).

iv. Resuscitation

The ABC of resuscitation as described in the Advanced Trauma Life Support (ATLS) Syllabus (22) provides the basis of good, quick, efficient practice in the initial management of a resuscitation scenario.

A = Airway with Cervical Spine control

B = Breathing

C = Circulation

The inability of health professionals to perform basic life support has been reported in nurses (23) and in doctors (24,25). With respect to airway and breathing, the use of the LMA may go some way towards improving this. A study was performed using 10 volunteers with no prior experience who were given limited training in the use of:

a) face mask, bag, and oropharyngeal airway, OR

b) the LMA.

They were then asked to secure the airway and maintain ventilation using both techniques on a number of patients. The time for successful insertion of the LMA compared to the mask and airway was not significantly longer, and successful ventilation was achieved in 87% using the LMA compared to 43% with mask and airway (26).

A large multicentre trial showed the effectiveness and ease of training in the use of the LMA (27). Nurses underwent a 90 minute training programme in the use of the LMA. This involved theory, practise on a mannikin, and then the need to perform 5 successful insertions on anaesthetised patients before being certified as competent. The training had to be repeated on a yearly basis. In resuscitation situations in which these staff were subsequently involved, an LMA was successfully inserted at the first attempt in 71% and on the second in a further 26%. The average time from the patient arresting to the airway being secured was 2.4 minutes. Good lung inflation was achieved in 88% of cases. Regurgitation had already occurred in 12% of cases and only occurred in a further 2% after insertion. Only one out of 164 cases had clinical evidence of pulmonary aspiration. It was thought by the authors that this could be less than the incidence if a face mask was used, as there may be less gastric distension using the LMA.

Other possibilities for the use of the LMA are in neonatal resuscitation (28), and in suspected cervical spine injury where it may be used with the minimum of movement of the neck (29). The high risk of a traumatised patient having a full stomach must be considered.

Use in the Military Environment

Military anaesthetists are already very familiar with the LMA having used it since very early in its development. In addition it has been used in active service in the Gulf, Rwanda, Belize and Bosnia. The LMA is widely used in Military Hospitals on a day to day basis.

Its use in resuscitation in the field needs to be explored. Airway management is the most difficult skill to acquire

in basic/advanced life support. Combat Medical Technicians (CMTs), nurses and doctors with limited expertise in airway management have and could be dealing with casualties in the battlefield for a prolonged period of time before more experienced help is available. The LMA is easy for personnel with limited experience to learn (26,27,30,31), and to use effectively compared to a facemask and pharyngeal airway.

The LMA is compact and requires no power source (unlike a laryngoscope which requires batteries), therefore making it amenable for inclusion in most medical kits.

The LMA also gets round the drawbacks of mouth to mouth (fear of infection e.g. HIV and Hepatitis B, or chemical contamination). Tracheal intubation as well as being technically more difficult is further handicapped by the limited opportunities to learn the skill combined with a lot of people wishing to learn it (Combat Medical Technicians, junior anaesthetists, Combat Anaesthetic Support Officers, Regimental Nursing Officers, paramedics, casualty staff and other emergency health care workers).

The LMA training programme as mentioned earlier (27) and also provided by the manufacturers (32) would be more practicable in teaching large numbers with limited resources.

Inclusion of the LMA into the ATLS (Advanced Trauma Life Support) syllabus (22) is likely to occur in the near future. The introduction of the LMA into the field would be best made via the BATLS (British Army Trauma Life Support) training programme. Its inclusion in airway management between the pharyngeal airway and the endotracheal tube can be justified in providing maximum benefit, to maximum numbers, with minimal resources used.

Conclusions

Correct use of the LMA is easy to teach inexperienced staff contrasting markedly with attempts to teach endotracheal intubation. The author's experience of teaching endotracheal intubation to a BATLS course revealed repeated failures to be common and long periods of instruction and practical experience. In combat the use of LMA was learnt quickly and required less time to acquire the skills in its proper use.

Future military developments include the concept of Immediate Care Ventilation: i.e. the provision of supplemental oxygen without the need for intubating or paralysing the casualty. The LMA will help fulfil this role and consequently save lives, especially in the scenario of overwhelming casualties due to NBC poisoning.

The LMA goes a long way towards filling the gap between the face mask and the endotracheal tube. Though not providing a fully secure airway in relatively unskilled hands it can provide a method of oxygenating the patient, when other methods may have failed. It must be remembered that it is failure to oxygenate, not failed intubation, that kills the patient.

Addendum

Method of Insertion

Prior to insertion the LMA must be sterilised. The method of choice is autoclaving at no higher than 134°C. The following checks must then be made (12). First the LMA should not be used over the recommended 40 occasions (each use should be logged). The integrity of the cuff is checked by inflation with 50% over the normal working volume, it is then fully deflated and will remain thus if the valve is functioning properly. The stem is then inspected for any discolouration, and should be able to bend 180° without kinking.

After confirming it is safe to use, the LMA is then lubricated just prior to insertion with a suitable gel on the back of the mask. Care is taken not to leave any globules of gel on the anterior surface which could be inhaled, causing coughing or laryngospasm.

For safe insertion, abolition of the laryngeal reflexes must be achieved by adequate depth of anaesthesia, the method of choice being Propofol 2-3mg/kg administered intravenously. In resuscitation situations, insertion may be possible without the use of drugs. The use of a neuromuscular blocking drug should not be necessary.

The original method involved the use of a metal introducer, as there was a problem with the epiglottis being folded down as the LMA was pushed in obstructing the airway (33). This was later dispensed with, and the following standard method described by the inventor (2) has not been improved on despite many suggestions (34).

1. Select the correct size of LMA for the patient.
2. Take the LMA by the stem and hold it like a pen.
3. Open the patient's mouth fully, extend the head and flex the neck. (See Figure 4).
4. Press the lubricated tip onto the hard palate so it flattens and apply pressure upwards so it slides back along the palate. (See Figure 5).
5. You then feel the mask change direction to move to the lower pharynx. If resistance is felt at this point either the tip has folded back or encountered an obstruction e.g. tonsillar tissue. Never use force, just withdraw and try a slight diagonal shift in approach. (See Figure 6).
6. Once into the lower pharynx, press downwards with a single rapid but gentle movement. This will position the mask with the tip meeting resistance against the upper oesophageal sphincter. (See Figure 7).
7. The cuff should then be inflated with the recommended volume of air:
size 1 - 2-4 mls
size 2 - up to 10 mls
size 3 - up to 25 mls
size 4 - up to 35 mls
On inflation of the cuff, the tube may appear to come back out of the mouth a fraction, this is normal.
8. Connection to the gas supply and confirmation of a clear airway should then occur.
9. The LMA should then be secured in place by taping or tie.

Fig 4.

Fig 5

Fig 6

Fig 7

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